



## Poker Cards Analysis - September 2023

### The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **September 01, 2023 to September 30, 2023** as recorded by the respective game servers and analyzed the Poker cards for statistical randomness. The results of the analysis are given below.

For details on the gaming sites serviced by the Entain Plc game servers and used in this audit refer to the [List](#).

### 1. Poker hand types statistics

These calculations were done for Royal Flush, Straight Flush, Four of a Kind, Full House, Flush, Straight, 3 of a Kind, 2 pairs, 1 Pair, High Card.

The Poker hand types analysis involved creating subsets of data and conducting Chi-square tests on each subset.

The null hypothesis for the chi-square test is that the observed frequencies of each type of hand matches the theoretical values for a deck that has been shuffled using a perfect random number generator. The p-values observed in these multiple tests are expected to follow a uniform distribution for the range 0.0 to 1.0.

The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the Poker hand types statistics tests.

#### 1.1 Poker hand types statistics for 52 cards deck:

Test No.	DOF	ChiSqr	P-Value
1	9	10.39	0.31975
2	9	4.15	0.90149
3	9	21.57	0.01033
4	9	7.55	0.57972
5	9	4.86	0.84616
6	9	9.27	0.41314
7	9	3.33	0.94998
8	9	6.01	0.73897
9	9	8.59	0.47549
10	9	7.19	0.61687
11	9	6.85	0.65284
12	9	6.61	0.67753
13	9	5.58	0.78088
14	9	3.03	0.96303
15	9	5.69	0.77046
16	9	4.77	0.85424
17	9	6.41	0.69817
18	9	8.23	0.51124
19	9	11.04	0.27293
20	9	3.51	0.94051
21	9	14.45	0.10709
22	9	4.76	0.85495
23	9	11.69	0.23157
24	9	9.91	0.35789
25	9	6.84	0.65372
26	9	8.71	0.46439
27	9	9.98	0.35203

28	9	3.84	0.92192
29	9	11.95	0.21622
30	9	6.21	0.71898
31	9	5.19	0.81702
32	9	13.53	0.13999
33	9	8.18	0.51656
34	9	7.18	0.61812
35	9	15.93	0.06831
36	9	8.19	0.51561
37	9	7.92	0.54196
38	9	7.55	0.58025
39	9	13.95	0.12410
40	9	6.65	0.67314
41	9	8.28	0.50660
42	9	9.33	0.40707
43	9	6.85	0.65285
44	9	16.26	0.06163
45	9	4.51	0.87502
46	9	8.50	0.48471
47	9	5.14	0.82203
48	9	7.78	0.55610
49	9	6.98	0.63928
50	9	10.40	0.31936
51	9	3.17	0.95698
52	9	5.68	0.77161
53	9	10.81	0.28866
54	9	2.92	0.96735
55	9	5.79	0.76090
56	9	3.92	0.91672
57	9	13.30	0.14931
58	9	13.89	0.12642
59	9	16.98	0.04900
60	9	10.33	0.32421
61	9	8.00	0.53429
62	9	7.69	0.56539
63	9	6.59	0.68023
64	9	3.71	0.92970
65	9	7.80	0.55453
66	9	5.44	0.79482
67	9	6.36	0.70384
68	9	2.26	0.98672
69	9	4.57	0.87019
70	9	2.59	0.97833
71	9	9.34	0.40630
72	9	5.80	0.75959
73	9	5.22	0.81463
74	9	6.69	0.66961
75	9	8.71	0.46484
76	9	12.64	0.17981
77	9	7.39	0.59637
78	9	7.62	0.57243
79	9	13.22	0.15280
80	9	11.86	0.22158
81	9	4.67	0.86208
82	9	7.31	0.60525
83	9	4.04	0.90886

84	9	8.67	0.46830
85	9	16.65	0.05451
86	9	3.89	0.91855
87	9	10.27	0.32927
88	9	8.13	0.52071
89	9	11.91	0.21822
90	9	9.47	0.39525
91	9	20.07	0.01749
92	9	13.95	0.12409
93	9	10.06	0.34562
94	9	2.23	0.98733
95	9	4.50	0.87560
96	9	10.31	0.32583
97	9	5.69	0.77093
98	9	18.47	0.03005
99	9	8.41	0.49358
100	9	2.77	0.97269
Combined P-value for all tests (Using KS method)			0.04908

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

## 1.2 Poker hand types statistics for 36 cards deck:

Test No.	DOF	ChiSqr	P-Value
1	8	2.17	0.97550
2	8	2.75	0.94900
3	8	13.17	0.10627
4	8	8.96	0.34535
Combined P-value for all tests (Using KS method)			N/A (Insufficient data)

Notes:

- 1) Since the number of samples available was insufficient to ensure at least 5 samples in the lowest probability hand type, (Royal Flush), the chi-square test has been performed by merging the Royal Flush and Straight Flush categories.
- 2) As the total number of tests (4) is insufficient to perform a meaningful KS Test, individual p-values from these tests are carried over to the next stage for combining using the Holm's method.
- 3) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 5 months - i.e April 2023 to September 2023.

## 2. Poker rank statistics

The Poker rank analysis aims to establish that the rank of the cards in each position was equally distributed in one of the 13 possible ranks (2, 3, 4, 5, 6, 7, 8, 9, 10, J, Q, K, A) for a 52 card deck and 9 ranks (6, 7, 8, 9, 10, J, Q, K, A) for a 36 card deck.

The Poker rank analysis involved creating subsets of data and conducting Chi-square tests on each subset. The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the Ranks statistics tests.

### 2.1 Poker rank statistics for 52 cards deck:

Test No.	DOF	ChiSqr	P-Value
1	84	67.76	0.90176
2	84	82.99	0.51080
3	84	96.85	0.15970

4	84	82.77	0.51736
5	84	92.68	0.24229
6	84	60.91	0.97288
7	84	111.47	0.02414
8	84	89.15	0.32970
9	84	87.98	0.36173
10	84	62.39	0.96281
11	84	77.72	0.67193
12	84	88.08	0.35906
13	84	66.46	0.92050
14	84	84.78	0.45568
15	84	104.60	0.06356
16	84	79.79	0.60966
17	84	71.89	0.82406
18	84	78.96	0.63514
19	84	82.69	0.51991
20	84	104.79	0.06199
21	84	90.59	0.29228
22	84	78.08	0.66139
23	84	101.99	0.08850
24	84	99.62	0.11736
25	84	81.14	0.56818
26	84	88.04	0.36015
27	84	80.16	0.59844
28	84	96.72	0.16182
29	84	83.09	0.50756
30	84	103.20	0.07607
31	84	77.60	0.67535
32	84	75.95	0.72243
33	84	75.51	0.73458
34	84	105.16	0.05904
35	84	69.56	0.87140
36	84	78.07	0.66169
37	84	89.96	0.30826
38	84	55.59	0.99286
39	84	97.11	0.15523
40	84	71.67	0.82902
41	84	72.64	0.80718
42	84	79.34	0.62357
43	84	67.80	0.90124
44	84	87.66	0.37071
45	84	92.80	0.23957
46	84	69.77	0.86754
47	84	73.92	0.77621
48	84	112.23	0.02154
49	84	68.74	0.88590
50	84	83.71	0.48843
51	84	91.07	0.28022
52	84	108.70	0.03626
53	84	85.33	0.43910
54	84	89.45	0.32159
55	84	79.69	0.61296
56	84	95.66	0.18090
57	84	65.28	0.93514
58	84	83.90	0.48248
59	84	88.25	0.35419

60	84	61.74	0.96749
61	84	59.39	0.98084
62	84	107.32	0.04401
63	84	89.07	0.33197
64	84	113.44	0.01787
65	84	81.11	0.56912
66	84	78.25	0.65641
67	84	57.01	0.98946
68	84	72.23	0.81655
69	84	85.30	0.44000
70	84	91.32	0.27408
71	84	97.45	0.14977
72	84	91.10	0.27957
73	84	63.32	0.95512
74	84	82.29	0.53237
75	84	81.37	0.56093
76	84	60.52	0.97510
77	84	73.35	0.79022
78	84	76.13	0.71758
79	84	93.44	0.22542
80	84	79.39	0.62206
81	84	78.17	0.65875
82	84	87.87	0.36487
83	84	75.43	0.73665
84	84	76.56	0.70535
85	84	73.35	0.79013
86	84	62.72	0.96022
87	84	68.08	0.89679
88	84	79.42	0.62117
89	84	90.64	0.29103
90	84	96.26	0.17000
91	84	69.12	0.87930
92	84	96.17	0.17159
93	84	83.71	0.48827
94	84	88.71	0.34152
95	84	75.36	0.73864
96	84	103.25	0.07557
97	84	71.13	0.84059
98	84	89.85	0.31115
99	84	74.77	0.75425
100	84	61.08	0.97180
Combined P-value for all tests (Using KS method)			0.70173

*Notes:*

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

## 2.2 Poker rank statistics for 36 cards deck:

Test No.	Positions	DOF	ChiSqr	P-Value
1	7	56	53.41	0.57359
2	7	56	35.43	0.98560
3	7	56	43.38	0.89094
4	7	56	50.38	0.68649
5	7	56	53.71	0.56189
6	7	56	52.49	0.60852
7	7	56	72.11	0.07236
8	7	56	42.16	0.91467
9	7	56	47.72	0.77661
10	7	56	68.53	0.12152
11	7	56	54.24	0.54191
12	7	56	39.85	0.94935
13	7	56	47.79	0.77435
14	7	56	71.95	0.07416
15	7	56	58.54	0.38243
16	7	56	55.73	0.48504
17	7	56	57.24	0.42900
Combined P-value for all tests (Using KS method)				0.42178

### Notes:

- 1) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 5 months - i.e April 2023 to September 2023.

## 3. Poker suits statistics

The Poker suits analysis aims to verify that that the cards dealt exhibit an equal probability of all 4 suits (Clubs, Diamonds, Hearts and Spades) in all positions.

The Poker suits analysis involved creating subsets of data and conducting Chi-square tests on each subset. The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the Suits statistics tests.

### 3.1 Poker suits statistics for 52 cards deck:

Test No.	Positions	DOF	ChiSqr	P-Value
1	7	21	17.95	0.65226
2	7	21	24.02	0.29200
3	7	21	19.33	0.56415
4	7	21	21.51	0.42821
5	7	21	27.69	0.14905
6	7	21	18.09	0.64304
7	7	21	17.51	0.67965
8	7	21	20.84	0.46892
9	7	21	29.65	0.09917
10	7	21	21.74	0.41453
11	7	21	22.54	0.36895
12	7	21	21.00	0.45870
13	7	21	15.79	0.78150
14	7	21	17.19	0.69960
15	7	21	28.19	0.13487

16	7	21	31.37	0.06777
17	7	21	14.34	0.85450
18	7	21	12.59	0.92234
19	7	21	25.77	0.21540
20	7	21	9.66	0.98299
21	7	21	16.21	0.75801
22	7	21	45.21	0.00163
23	7	21	27.05	0.16905
24	7	21	9.29	0.98670
25	7	21	18.71	0.60364
26	7	21	18.37	0.62528
27	7	21	12.30	0.93103
28	7	21	23.79	0.30343
29	7	21	24.69	0.26086
30	7	21	16.01	0.76932
31	7	21	22.62	0.36438
32	7	21	21.90	0.40519
33	7	21	16.68	0.73040
34	7	21	29.18	0.10971
35	7	21	19.20	0.57235
36	7	21	23.07	0.34041
37	7	21	12.09	0.93721
38	7	21	23.05	0.34125
39	7	21	17.94	0.65299
40	7	21	21.22	0.44535
41	7	21	16.37	0.74852
42	7	21	29.13	0.11083
43	7	21	24.53	0.26823
44	7	21	18.51	0.61649
45	7	21	36.06	0.02155
46	7	21	34.53	0.03174
47	7	21	13.10	0.90522
48	7	21	15.48	0.79830
49	7	21	21.22	0.44562
50	7	21	14.93	0.82629
51	7	21	35.45	0.02518
52	7	21	12.78	0.91619
53	7	21	18.52	0.61581
54	7	21	17.12	0.70397
55	7	21	25.17	0.23988
56	7	21	15.05	0.82022
57	7	21	16.00	0.76966
58	7	21	10.34	0.97412
59	7	21	12.24	0.93305
60	7	21	19.48	0.55460
61	7	21	11.64	0.94890
62	7	21	29.07	0.11230
63	7	21	29.55	0.10143
64	7	21	20.19	0.50934
65	7	21	15.41	0.80207
66	7	21	23.51	0.31745
67	7	21	14.96	0.82493
68	7	21	23.82	0.30163
69	7	21	21.36	0.43689
70	7	21	19.49	0.55349
71	7	21	20.38	0.49709

72	7	21	18.16	0.63911
73	7	21	14.23	0.85953
74	7	21	18.61	0.61016
75	7	21	27.58	0.15234
76	7	21	26.06	0.20418
77	7	21	24.89	0.25184
78	7	21	8.53	0.99244
79	7	21	23.40	0.32315
80	7	21	23.78	0.30365
81	7	21	18.98	0.58667
82	7	21	33.03	0.04594
83	7	21	21.24	0.44452
84	7	21	28.60	0.12391
85	7	21	23.17	0.33514
86	7	21	22.35	0.37952
87	7	21	40.40	0.00664
88	7	21	17.00	0.71120
89	7	21	28.81	0.11860
90	7	21	17.20	0.69871
91	7	21	19.40	0.55934
92	7	21	31.15	0.07119
93	7	21	20.42	0.49495
94	7	21	20.87	0.46684
95	7	21	14.68	0.83853
96	7	21	23.07	0.34035
97	7	21	15.89	0.77564
98	7	21	14.55	0.84487
99	7	21	20.38	0.49738
100	7	21	9.16	0.98793
Combined P-value for all tests (Using KS method)				0.99354

**Notes:**

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

**3.2 Poker suits statistics for 36 cards deck:**

Test No.	Positions	DOF	ChiSqr	P-Value
1	7	21	27.22	0.16356
2	7	21	24.06	0.28997
3	7	21	22.18	0.38943
4	7	21	27.42	0.15726
5	7	21	24.25	0.28120
6	7	21	12.35	0.92962
7	7	21	18.62	0.60925
8	7	21	16.33	0.75095
9	7	21	23.97	0.29461
10	7	21	19.86	0.53040
11	7	21	19.38	0.56052
12	7	21	14.26	0.85835
13	7	21	14.45	0.84960
14	7	21	27.54	0.15356
15	7	21	22.94	0.34697
16	7	21	23.59	0.31324
17	7	21	17.55	0.67748



Combined P-value for all tests (Using KS method)	0.78315
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Notes:

- 1) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 5 months - i.e April 2023 to September 2023.

## 4. Summary of the analysis

### 4.1 Summary of the analysis of 52 cards deck:

The analysis of 52 cards is completed by combining the result of the KS Test performed in the 3 types of analysis (Hand Types, Ranks and Suits) for 52 card decks using the Holm's method and producing a single Combined P -value.

The combined p-value produced using the Holm's method is used as indication for statistical randomness.

Combination of p-values using Holm's Method		
Test	P-Value	P-Adjusted
Ranks Test	0.70173	1.00000
Suits Test	0.99354	1.00000
Hand Types Test	0.04908	0.14724
<b>Combined P-Value using Holm's Method</b>		0.14724

Notes:

- 1) The combined p-value of all statistical tests using Holm's Method conducted for 52 card decks is greater than the minimum value of 0.05 which indicates that the randomness of the observed data falls within 95% confidence limits.

The final outcome of the analysis of 52 cards deck indicates that the RNG is working correctly.

### 4.2 Summary of the analysis of 36 cards deck:

The analysis of 36 cards completes by combining the result of the KS Test performed in the 3 types of analysis (Hand Types, Ranks and Suits) for 36 card decks using the Holm's method and producing a single Combined P -value. Where there is insufficient data the individual Chi-Square tests results are used in the Holm's method for producing a combined p-value.

The combined p-value produced from the using the Holm's method is used as indication for statistical randomness.

Combination of p-values using Holm's Method		
Test	P-Value	P-Adjusted
Ranks Test	0.42178	1.00000
Suits Test	0.78315	1.00000
Hand Types Test 1	0.97550	1.00000
Hand Types Test 2	0.94900	1.00000
Hand Types Test 3	0.10627	0.63760
Hand Types Test 4	0.34535	1.00000
<b>Combined P-Value using Holm's Method</b>		0.63760

Notes:

- 1) The combined p-value of all statistical tests using Holm's Method conducted for 36 card decks is greater than the minimum value of 0.05 which indicates that the randomness of the observed data falls within 95% confidence limits.
- 2) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 5 months - i.e April 2023 to September 2023.

The final outcome of the analysis of 36 cards deck indicates that the RNG is working correctly.

## 5. Conclusion

Analysis of actual data from game logs for 'Hand Types', 'Ranks' and 'Suits' for **52-card decks** and **36-card decks** indicated statistical randomness.

iTech Labs has done limited sanity checks to verify the integrity of the game logs. iTech Labs also maintains a copy of the game logs for verification purposes. There were a large enough number of game records to give the calculations sufficient statistical power.

We conclude that the Random Number Generator (RNG) is working correctly.

Please click here to see the [Original](#) report.

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**Signed:**



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**Alvin Rizaldi**  
**Chief Executive Officer**  
**iTech Labs**  
Date: 23 November 2023

**Signed:**



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**Divya Bhargava**  
**Project Manager**  
**iTech Labs**  
Date: 23 November 2023

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Disclaimer.

While it is not possible to test all possible scenarios in a laboratory environment, iTech Labs has conducted a level of testing appropriate for a component test of this type.